General Disclaimer

One or more of the Following Statements may affect this Document

- This document has been reproduced from the best copy furnished by the organizational source. It is being released in the interest of making available as much information as possible.

- This document may contain data, which exceeds the sheet parameters. It was furnished in this condition by the organizational source and is the best copy available.

- This document may contain tone-on-tone or color graphs, charts and/or pictures, which have been reproduced in black and white.

- This document is paginated as submitted by the original source.

- Portions of this document are not fully legible due to the historical nature of some of the material. However, it is the best reproduction available from the original submission.

RSI-SDSU-75-08

Investigation of Remote Sensing Techniques as Inputs to Operational Resource Management Models

Dr. Fred A. Schmer
Mr. Robert E. Isakson
Remote Sensing Institute
South Dakota State University
Brookings, South Dakota 57006

September 1975
Interim Type II Report for Period June - September 1975

Prepared for:
Goddard Space Flight Center
Greenbelt, Maryland 20771

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
2		

4. Title and Subtitle	5. Report Date
Investigation of Remote Sensing Techniques as Inputs to Operational Resource Management Models	September, 1975
	6. Performing Organization Code

7. Author(s)	8. Performing Organization Report No.
F.A. Schmer, R.E. Isakson	RSI-SDSU-75-08

9. Performing Organization Name and Address	10. Work Unit No.
Remote Sensing Institute South Dakota State University Brookings, South Dakota 57006	11. Contract or Grant No. NAS5-20982
	13. Type of Report and Period Covered Type II June 11 - Sept 10, 1975
12. Sponsoring Agency Name and Address NASA Goddard Space Flight Center Fred Gordon - Technical Monitor Greenbelt, MD 20771	14. Sponsoring Agency Code

15. Supplementary Notes Participating South Dakota State Government agencies include the State Planning Bureau, the Department of Game, Fish and Parks, the Department of Natural Resources Development, and the Black Hills Conservancy Subdistrict.

16. Abstract

Initial NASA RB-57 and RSI low-altitude underflights to LANDSAT were conducted in late June and early July. August cloud cover conditions prevented the second scheduled RSI mission over selected sites. With available LANDSAT and supporting aircraft and ground truth data, work has been initiated on producing data products for evaluation and use in a resource inventory of the Belle Fourche River Basin, forestry typing, surface water management programs, and crop identification. Entry of data into a computerized data base is being evaluated for applicability in data management.

Original photography may be purchased from:
EROS Data Center
10th and Dakota Avenue
Sioux Falls, SD 57198

ORIGINAL CONTAINS COLOR ILLUSTRATIONS

17. Key Words Suggested by Author	18. Distribution Statement
LANDSAT, Remote Sensing, Resource Management, State of South Dakota, Operational	

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
U	U	11	

PREFACE

During this reporting period, initial aircraft support flights to LANDSAT and ground truth data collection have been conducted. Preliminary studies and application of LANDSAT and aircraft remote sensing data have begun. Cloud cover restricted both aircraft and LANDSAT data collection. Initial aircraft underflights to LANDSAT were conducted in late June and early July, and the August RSI mission over selected sites was eliminated by cloud conditions. Available LANDSAT data has permitted initial studies to begin. Ground truth crop identification data have been plotted on low altitude aircraft data as crop identification studies commence. LANDSAT MSS data is being visually interpreted for Level I land use information to be used in a resource inventory of the Belle Fourche River Basin. LANDSAT MSS7 imagery, with road networks superimposed, is being evaluated for applicability in water management of the area. A computerized hierarchal data base is being evaluated for applicability in providing state agencies a practical method of storing and manipulating resource data.

TABLE OF CONTENTS

LIST OF FIGURES

INTRODUCTION

This is the second quarterly report of LANDSAT Follow-On Project, NASA contract NAS5-20982. Included during this quarter were initial aircraft support flights to LANDSAT and preliminary studies and applications of LANDSAT and aircraft remote sensing data.

PROBLEMS

Cloud conditions generated the major portion of the problems thus far into the project. Clouds delayed the initial RB-57 flight from the first 15 days in June to two data takes - the 25th of June and July 13. From verbal reports of the NASA mission managers, it is our understanding that both sets of data contain cloud cover and there is no color infrared imagery from the second data set. No microfilm has been received for review of RB-57 data and consequently, an order cannot be initiated. We are now in the twelfth week since the data take.

The next scheduled data take, by RSI only, was for the first two weeks in August. Excessive clouds were in the test site area all month. During the first week in September, a decision was made to cancel the flight as the third scheduled mission (concurrent with RB-57) could be as soon as September 15 and two sets of data within this short time frame would be of dubious value.

During the first week in September it was learned that the RB-57 aircraft scheduled for this project has been grounded at least until November and as of this writing no alternate source of high altitude imagery is scheduled. The importance of high altitude imagery cannot be overemphasized. The project has, from the outset, been

designed as a multi-stage evaluation of remote sensing by South Dakota governmental agencies. The imagery was to be used as an adjunct to ground truth data in such studies as land use mapping, forest typing, range conditions, surface water inventories, and vegetation typing. The thus far undetermined cloud cover percentages and lack of color infrared data on the initial data set place additional emphasis on the need for a second high altitude mission as scheduled.

Cloud cover has also plagued LANDSAT data. Since initiation of the standing order at EROS, only two images of the Black Hills Area have been useable. The data were collected June 12 and July 27 by LANDSAT 1 and 2, respectively. LANDSAT 1 data was obtained by funds provided the State of South Dakota. The problems in receipt of timely data has caused a setback in the projected progress on the project but hopefully timely data will be forthcoming and rearrangement of schedules will allow all of the objectives to be accomplished.

ACCOMPLISHMENTS

Apprehension on the part of participating state agency personnel regarding the use of remote sensing data has resulted in a change of "attack" on the part of Remote Sensing Institute (RSI) personnel. RSI is producing a variety of data products, including land use, surface water, and forest type, to demonstrate to the agencies how the interpretation of data is accomplished. Agency personnel are being brought to the Institute on an individual basis for training and work sessions on the interpretation and use of such data. This approach, while not the preferred one of direct involvement from the beginning of analysis, is deemed appropriate at this time. The agencies are involved

in that the areas and topics of study have been selected by them and ground truth data have been collected by agency personnel.

An hierarchal data base/information storage-retrieval system is being evaluated for use by State agencies in conjunction with remotely sensed data. Essentially, the system involves establishment of a grid system over an area of interest and manually coding data into the data base. Any information can be entered into the data base, e.g. land use, surface water, range conditions, slope of land, and wildlife population densities. The software allows computer generated "overlays" of data to be mapped at any desired scale, via a Calcomp plotter.

Specific accomplishments as they relate to various state agencies will be briefly reviewed.

State Planning Bureau

Preliminary work, in conjunction with the Department of Natural Resources Development, has been initiated for crop identification. Test sections have been identified on low altitude aircraft imagery and annotation of ground truth data has begun. Useful LANDSAT data has begun arriving and enlargements of test areas will allow for initial interpretations. Ground truth obtained via on-site verification and interpretation of aircraft data will be utilized to determine adequacy of CCT identification algorithms.

Department of Natural Resources Development

The Department has a Legislative mandate to conduct resource inventories of the State's nearly twenty river basins, develop a statewide

water resources management plan and update the inventories every four years. One of the major reasons for the Natural Resources Department entering this project was for conducting an evaluation of remote sensing in providing portions of the required resource data.

A basin-wide surface water and Level I land use inventory are being interpreted from LANDSAT data and entered into a data base. The data will be used in the Department's resource inventory of the Belle Fourche River Basin and the procedures involved will be evaluated for applicability to other basins. The interpretations are being conducted on a Zoom Transfer Scope (ZTS) using 1:1,000,000 color composite transparencies for land use and 1:1,000,000 MSS7 transparencies for surface water. The LANDSAT image is registered with a USGS 1:250,000 Quadrangle map to ensure geometric accuracy of the final product.

Figure 1 is a representation of the method being developed for entry of surface water information into a data base. Following interpretation of LANDSAT imagery on the ZTS, the data were entered into a date base via manual coding of the 16.2 hectare (40 acre) cells where surface water exists. The approximate size of the water body is estimated by visual comparison with the basic cell size. A Calcomp plotter output has been color coded and ground-referenced and is seen in Figure 1. The data base allows for entry of two additional "descriptors" about the surface water.

Figure 2 is a photograph of a Lawrence County Level 1 land use map, interpreted from LANDSAT imagery, entered into a data base, and displayed on a color monitor via RSI's Signal Analysis and Dissemination Equipment. While the Calcomp output of lines and numerical descriptors

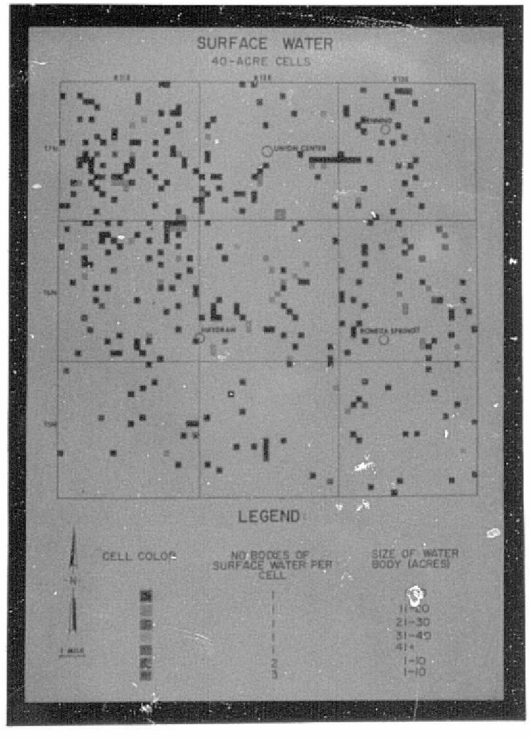

Figure 1. Interpreted LANDSAT MSS7 surface water data as entered into data base.

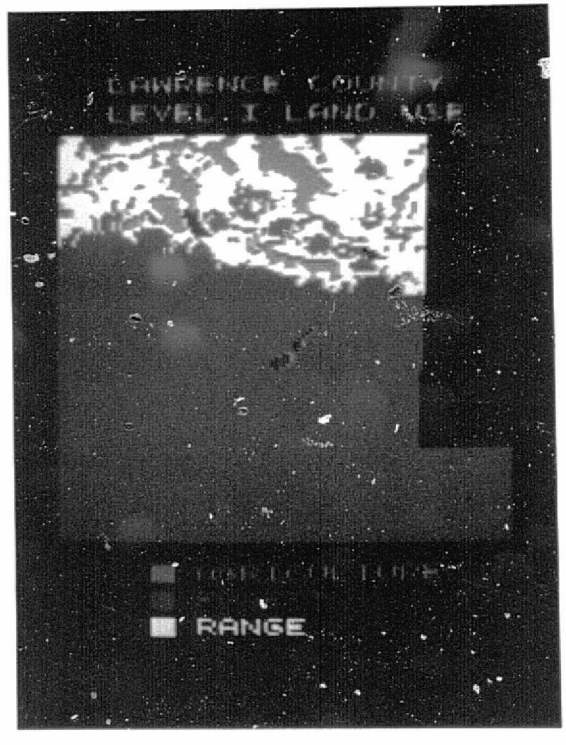

Figure 2. Interpreted LANDSAT color composite land use data as color-keyed and displayed via SADE.

may be adequate for most work, the added dimension of color, plus the ability to selectively display and electronically planimeter individual color categories would be of benefit to certain studies, reports, and presentations.

Game Fish and Parks Department

The vicinity of the confluence of the Belle Fourche and Cheyenne Rivers provides Game Fish and Parks personnel with a 48km x 56km test site to evaluate techniques developed for analysis of remote sensing data. The Department is in need of a detailed evaluation of the test site for wildlife habitability and potential development of the land. The area has been divided into a grid with 50.3m x 50.3m cells. Data already entered into the data base include land elevation (30.3m (100') contours from a 1:24,000 USGS Quadrangle map), and surface water, as interpreted from recent LANDSAT MSS7 imagery. Material being prepared for entry into the data base include range condition (as interpreted from a LANDSAT color composite), drainage network (from a Quadrangle map and aircraft imagery), and vegetation types (from aircraft and LANDSAT data).

The Department Fisheries Biologist is interested in surface water data. RSI has prepared LANDSAT MSS7 with a road network superimposed onto the photographs, selected prints of which are seen in Figure 3. LANDSAT data from a wet year and a dry year have been used. Black and white enlargements, similar to those seen in Figure 3, are being taken into the field by Game, Fish, and Parks personnel and used in 1) locating water bodies, 2) evaluating water bodies for wildlife support potential, and inventory and record keeping. For example

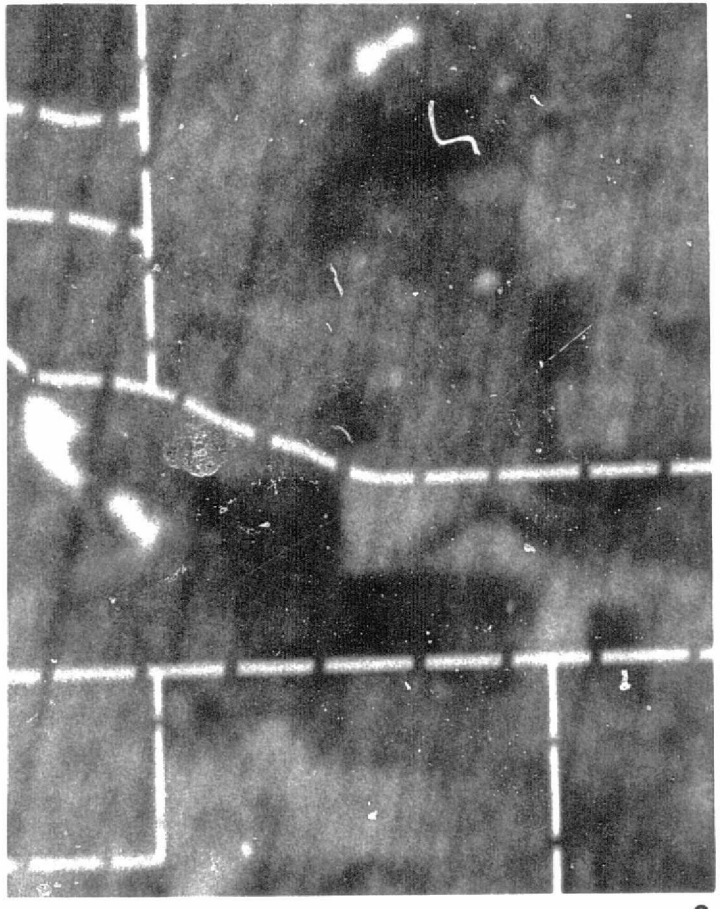

Figure 3a.

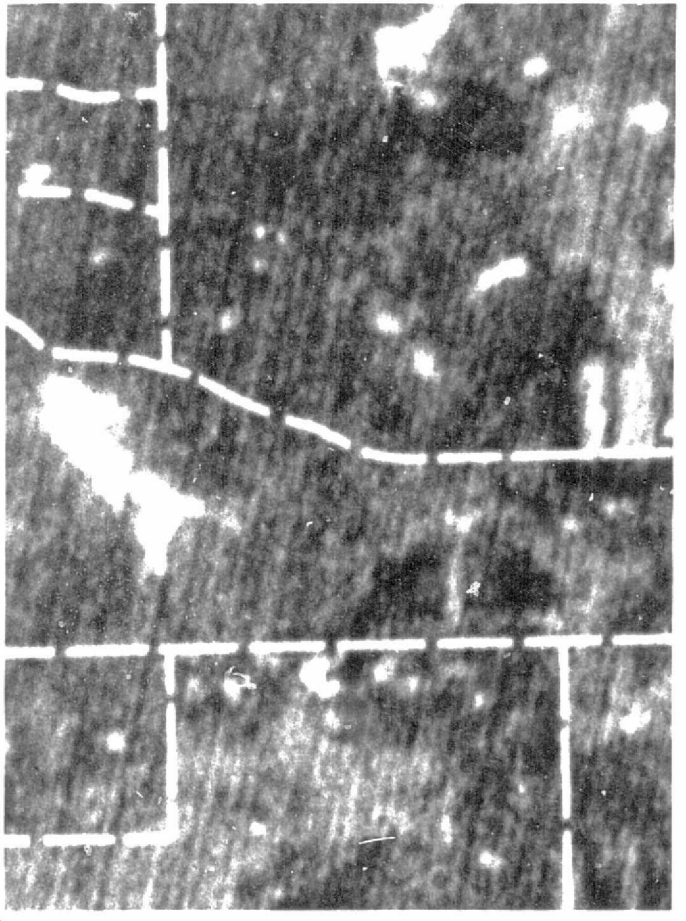

Figure 3b.

Figure 3. LANDSAT MSS7 imagery with superimposed road network. Data in Figure 3a is representative of a dry year and that of 3b, a wet year.

water bodies not appearing in a dry year are not considered for potential fisheries development but are important for other wildlife propogation.

The Forestry section of the Department is cooperating in a study evaluating the potential of aspen as a livestock feed. Heretofore, as aspen areas have been thinned for improved wildlife and forestry management, the removed aspen is a liability, incurring considerable expense for removal. Now, studies are indicating that pulverized aspen, if fed to cattle, produces weight gains approaching and surpassing gains registered with conventional feeds. Further research is being conducted, and if the feasibility of aspen feed develops, the harvesting of aspen trees may become an asset rather than a liability, and the location of aspen groves takes on added importance. In fact the potential for encouraging aspen stands appears close to reality and resourse base inventory information is needed. Mosaics of low altitude imagery over forested sites have been prepared and LANDSAT enlargements of the area are printed. Ground truth of existing aspen groves has been annotated on low altitude color infrared prints. Techniques to use remote sensing in the inventory process are being investigated.

PUBLICATIONS

A formal presentation on RSI and this LANDSAT project was given to the Black Hills County Commissioners Association in Belle Fourche, August 21. Approximately 50 County Officials from ten western South Dakota counties attended the meeting. The general talk outline follows that contained in Appendix B of the first quarterly report on this project (RSI-SDSU-75-07).

FUNDS EXPENDED

Total funds expended through August 31, 1975: is $27,808.31. This does not include costs incurred by state agency participants as they will be invoicing on a quarterly basis.

DATA USE

Value of Data Allowed - $11,944

Value of Data Ordered - $1670

Value of Data Received - $1330

AIRCRAFT DATA

RB-57 data collected for this project is not available as of this writing. However, 1974 RB-57 imagery was valuable in aspen and diseased tree studies to allow for the location of potential sites and may be meaningful in observing trends. This data is available at RSI via the ongoing NASA grant NGL 42-003-007 but does not cover the complete Belle Fourche River Basin. The 1974 imagery was of value in establishing accurate grid registration on LANDSAT imagery and for the accurate registration of the road network over LANDSAT MSS7 imagery.

Low altitude aircraft data is very valuable in that it is a direct suppliment to ground truth data and will be used extensively as the project progresses.

PROGRAM FOR NEXT REPORTING PERIOD

Hopefully the initial copy of RB-57 imagery and a second RSI aircraft data set will be available to assist in evaluation of LANDSAT data. Evaluation of LANDSAT imagery as a data source will be conducted

with emphasis on entering interpreted data into a data base.

Computer work will involve development and evaluation of software to facilitate data base analyses in areas such as: cell aggregation, calculations using digitized data (e.g. drainage density and runoff predictions), and automatic entry of data into the data base.

Specific areas of concentration include forest typing and disease analysis studies. Visual and digital interpretation procedures will be explored. Additional work will continue with the test site of interest to Game Fish and Parks personnel. Data base information will be used as an added tool in the wildlife management decision-making processes employed by the Department.

Level I land use maps of the Basin will be visually interpreted from early June and late July LANDSAT data sets. The June and July dates were selected based on agricultural practices of the area. In particular, ranchers periodically cut native grassland. The cut areas resemble fields on LANDSAT imagery and are often interpreted as agricultural land when, in fact, they are natural rangeland. Comparison of the two maps, along with ground truth and aircraft data will assist in determining prime dates for visual LANDSAT land use mapping of the area.

Surface water for a dry period and a wet period will be interpreted on a basin-wide basis for use in inventories and wildlife management studies. Crop identification capabilities of LANDSAT will be evaluated using available ground truth and associated aircraft data.

More importantly, having presented sample data products to participating agencies and evaluating applicability of such data, par-

ticipating agency personnel will be brought to RSI individually for training in the interpretation and evaluation of this new data source. While at the Institute, agency personnel will provide a valuable input to the development of data products which will be practical and useable from their respective points of view.

CONCLUSIONS

The emphasis of the project continues to be on active participation by State agency personnel. Major efforts will be expended to get at least one person from each department familiar with remote sensing and trained in the interpretation and application of applicable LANDSAT, and other, data sources. The interest and enthusiasm is there, it is now a matter of meshing agency requirements with remote sensing's capabilities.

RECOMMENDATIONS

Reduced turn-around time for both aircraft and LANDSAT data products would allow for earlier initiation of studies and contribute to the timeliness of the results.